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Effect of oolong tea (*Camellia sinensis*) powder particle size on growth performance, fat deposition, meat quality and antioxidant activity in meat ducks

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ABSTRACT

An experiment was conducted to investigate the effect of oolong tea (*Camellia sinensis*) powder (OTP) particle size on growth performance, fat deposition, meat quality and antioxidant activity of ducks. A total of 252 Cherry Valley meat ducks (16 days old) with similar initial body weight (744 ± 6 g) were selected and randomly divided into three groups with six replicates of fourteen ducks (seven males and seven females) each and fed a control diet or one of two test diets supplemented with 1% OTP with two different mean particle sizes categorised as coarse (357 μm) and fine (16 μm) until 42 days of age. Treatments did not affect growth performance of ducks. Abdominal fat yield, subcutaneous fat thickness, intramuscular fat width and serum triglyceride (TG) concentration were reduced ($P < 0.05$) by fine but not coarse OTP. Both forms of OTP decreased ($P < 0.05$) drip loss of pectoralis major muscle, but only fine OTP increased ($P < 0.05$) superoxide dismutase (SOD) activity and decreased ($P < 0.05$) malondialdehyde (MDA) content in serum. In conclusion, fine OTP would be more effective in decreasing fat deposition and improving meat quality and antioxidant activity in meat ducks.

1. Introduction

Tea (*Camellia sinensis*) is one of the most widely consumed beverages in the world, and it has been used for medicinal purposes for centuries. It contains many bioactive components, such as catechins, caffeine and amino acids (Wu and Wei, 2002). The application of tea in animals has recently received some attention due to its biological characteristics, such as hypolipidemic, antioxidant and antimicrobial activities (Hamer, 2007). According to the degree of fermentation, tea is classified into green tea (unfermented), oolong tea (semi-fermented), and black tea (fully fermented). Green tea has been extensively studied as a feed additive to regulate fat deposition and meat quality in animals (Biswas and Wakita, 2001; Erener et al., 2011; Hossain et al., 2012). It has been reported that oolong tea contains several low molecular weight antioxidants (Zhu et al., 2002), and exerts stronger hypolipidemic effect than green tea in rats (Kuo et al., 2005), thus it would be valuable

Abbreviations: ADFI, average daily feed intake; ADG, average daily gain; FCR, feed conversion ratio; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MDA, malondialdehyde; OTP, oolong tea powder; SOD, superoxide dismutase; T-AOC, total antioxidant capacity; TC, total cholesterol; TG, triglyceride.

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to evaluate the effect of dietary oolong tea in animals. However, there is limited literature on the effects of oolong tea. In addition, particle size is an important factor affecting the bioavailability of tea ingredients (Li et al., 2008; Maeda-Yamamoto et al., 2011). Fine grinding was reported to increase extraction rate of polyphenols from green tea leaves, which enhanced their scavenging capacity on hydroxyl radicals (Hu et al., 2012), but few studies have been performed on the effects of tea particle size on the growth performance of animals. Therefore, the objective of this study was to evaluate the effect of oolong tea particle size on growth performance, fat deposition, meat quality and antioxidant activity in meat ducks.

2. Materials and methods

2.1. Husbandry, diets and experimental design

All procedures were approved by Nanjing Agricultural University Institutional Animal Care and Use Committee.

The Tieguanyin oolong tea (*C. sinensis*) used in this study was purchased from a local market and contained 12.42% polyphenols, 5.76% caffeine, and 3.86% amino acids as dry matter basis. It was pulverized to powder with different mean particle sizes categorised as coarse (357 μm) and fine (16 μm) by a jet mill (TC-20, Nanjing LT Ultra-fine Powder Technique Co., Ltd, Nanjing, Jiangsu, China). Mean particle sizes of oolong tea powder (OTP) were measured by the laser diffraction scattering method (Mastersizer 2000, Malvern Instruments Ltd., Worcestershire, UK).

One-day-old Cherry Valley meat ducks were obtained from a local hatchery and fed a commercial starter diet containing 216 g/kg crude protein and 12.0 MJ/kg apparent metabolisable energy to 15 days of age. At 16 days of age, a total of 252 ducks with similar body weight (744 ± 6 g) were selected and randomly divided into 3 groups with 6 replicates of 14 ducks (7 males and 7 females) in each, and fed a control finisher diet (165 g/kg crude protein and 12.4 MJ/kg apparent metabolisable energy) or one of two test diets supplemented with 1% coarse or fine OTP until 42 days of age. Ingredient composition and calculated nutrient content of the basal diet were shown in Table 1. Ducks were allowed free access to pellet feed and water on a plastic mesh that was placed 0.4 m above the floor. Continuous light was maintained and the temperature of the experimental room was set at 26 to 28 °C initially and then reduced by 2 °C per week to a final temperature of 20 to 22 °C. At 42 days of age, ducks were weighed and feed consumption was recorded by replicate to calculate average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR, feed intake/weight gain). Mortality was also recorded.

At 42 days of age, one male duck per replicate was randomly selected and weighed after feed deprivation for 12 h. Blood samples (about 5 mL each) were taken from wing vein and centrifuged at 3000 × *g* for 15 min at 4 °C to separate serum, which was frozen at −20 °C for further analysis. After blood collection, ducks were killed by cervical dislocation. Pectoralis major muscle samples were immediately taken and stored at 4 °C for meat quality analysis. Abdominal fat yield was calculated as the percentage of eviscerated weight. Subcutaneous fat thickness and intramuscular fat width were measured by a vernier caliper as previously described (Wu et al., 2012).

Table 1
Ingredient composition and calculated nutrient content of the basal diet (g/kg, as-fed basis unless otherwise stated).

Item	16–42 d
Ingredients	
Maize	425
Rice bran	220
Wheat middlings	156
Soybean meal (460 g CP[a]/kg)	96
Meat and bone meal	25
Maize gluten meal	35
Soybean oil	12
Limestone	12
Dicalcium phosphate	5
L-Lysine HCl	5
DL-Methionine	1
Premix[b]	8
Calculated nutrient content	
Apparent metabolisable energy (MJ/kg)	12.35
Crude protein	165
Lysine	10
Methionine	3.8
Total sulfur amino acids	6.5
Calcium	8.3
Available phosphorus	3.2

[a] Crude protein.
[b] Supplied per kilogram of diet: transretinyl acetate, 11,250 IU; cholecalciferol, 3000 IU; all-rac-α-tocopherol acetate, 37.5 mg; menadione, 3 mg; thiamin, 4 mg; riboflavin, 7.2 mg; nicotinamide, 55 mg; choline chloride, 1000 mg; calcium pantothenate, 60 mg; pyridoxine·HCl, 4 mg; biotin, 0.2 mg; folic acid, 1 mg; cobalamin, 0.02 mg; Fe (ferrous sulfate), 96 mg; Cu (copper sulfate), 7.5 mg; Mn (manganese sulfate), 110 mg; Zn (zinc oxide), 84 mg; I (calcium iodate), 0.4 mg; Se (sodium selenite), 0.3 mg.